

Recent Advances for Quantum Neural Networks in Generative Learning

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Abstract

Quantum computers are next-generation devices that hold promise to perform calculations beyond the reach of classical computers. A leading method towards achieving this goal is through quantum machine learning, especially quantum generative learning. Due to the intrinsic probabilistic nature of quantum mechanics, it is reasonable to postulate that quantum generative learning models (QGLMs) may surpass their classical counterparts. As such, QGLMs are receiving growing attention from the quantum physics and computer science communities, where various QGLMs that can be efficiently implemented on near-term quantum machines with potential computational advantages are proposed. In this paper, we review the current progress of QGLMs from the perspective of machine learning. Particularly, we interpret these QGLMs, covering quantum circuit Born machines, quantum generative adversarial networks, quantum Boltzmann machines, and quantum variational autoencoders, as the quantum extension of classical generative learning models. In this context, we explore their intrinsic relations and their fundamental differences. We further summarize the potential applications of QGLMs in both conventional machine learning tasks and quantum physics. Last, we discuss the challenges and further research directions for QGLMs.